Chemical Reactions

Chemical reactions occur when chemical bonds form or break among atoms, ions, or molecules

Reactants are the starting materials of the reaction - the atoms, ions, or molecules

Products are substances formed at the end of the chemical reaction

$$NaCl \rightarrow Na^+ + Cl^-$$

Reactant **Products**

Chapter 2 | Part 2

Types of Chemical Reactions

Synthesis Reaction – more complex chemical structure is formed

A + B ’ AB

Decomposition Reaction – chemical bonds are broken to form a simpler chemical structure

AB ’ A + B

Exchange Reaction – chemical bonds are broken and new bonds are formed

AB + CD ’ AD + CB

Reversible Reaction – the products can change back to the reactants

A + B n AB

Acids, Bases, and Salts

Electrolytes – substances that release ions in water

$$NaCl \rightarrow Na^+ + Cl^-$$

ids – electrolytes that dissociate to release hydrogen i water

$$HCl \rightarrow H^+ + Cl^-$$

Bases – substances that release ions that can combine with hydrogen ions

$$NaOH \rightarrow Na^+ + OH^-$$

Salts – electrolytes formed by the reaction between an acid and a base

$$HCl + NaOH \rightarrow H_2O + NaCl$$

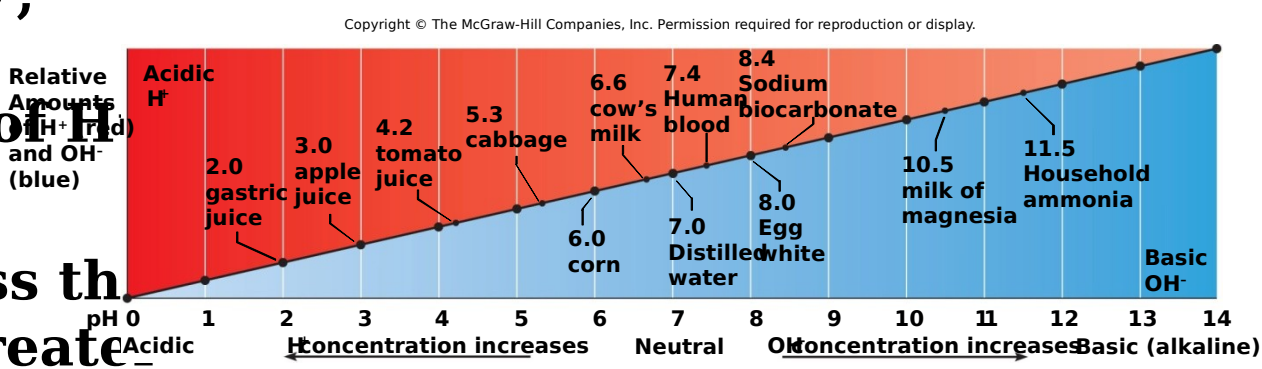
Acid and Base Concentration

pH scale – indicates the concentration of hydrogen ions in solution

Neutral – pH 7; indicates equal concentrations of H^+ and OH^-

Acidic – pH less than 7; indicates a greater concentration of H^+

Basic or alkaline – pH greater than 7; indicates a greater concentration of OH^-



Neutralization and Buffers

- Neutralization occurs when an acid and base react to form a salt and water in a displacement reaction.
  - $HCl + NaOH \rightarrow NaCl + H_2O$
  - Termed **neutralization** because water is formed neutralizing the solution.
- **Buffers** act as acids when pH is high and bases when pH is low.
  - Carbonic acid-bicarbonate system.

2.3: Chemical Constituents of Cells

Organic v. Inorganic Molecules

Organic molecules

- Contain C and H
- Usually larger than inorganic molecules
- Dissolve in water and organic liquids
- Carbohydrates, proteins, lipids, and nucleic acids

Inorganic molecules

- Generally do not contain C and H
- Usually smaller than organic molecules
- Usually dissociate in water, forming ions
- Water, oxygen, carbon dioxide, and inorganic salts

Inorganic Substances

Water

- Most abundant compound in living material
- Two-thirds of the weight of an adult human
- Major component of all body fluids
- Medium for most metabolic reactions
- Important role in transporting chemicals in the body
- Absorbs and transports heat

Oxygen (O_2)

- Used by organelles to release energy from nutrients in order to drive cell's metabolic activities
- Necessary for survival

Inorganic Substances

Carbon dioxide (CO_2)

- **Waste product released during metabolic reactions**
- **Must be removed from the body**

Inorganic salts

- **Abundant in body fluids**
- **Sources of necessary ions (Na^+, Cl^-, K^+, Ca^{2+}, etc.)**
- **Play important roles in metabolism**

Organic Substances Carbohydrates

- Provide energy to cells
- Supply materials to build cell structures
  - Water-soluble
  - Contain C, H, and O
- Ratio of H to O close to 2:1 ($C_6H_{12}O_6$)
  - Monosaccharides – glucose, fructose
  - Disaccharides – sucrose, lactose
  - Polysaccharides – glycogen, cellulose

Organic Substances
Carbohydrates

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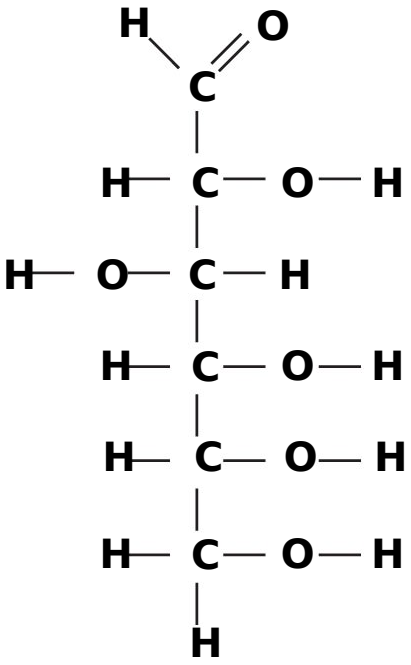

(a) Some glucose molecules ($C^6H^{12}O^6$) have a straight chain of carbon atoms.

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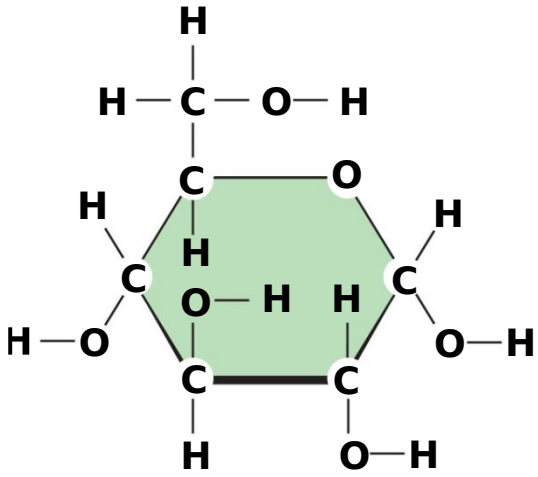

(b) More commonly, glucose molecules form a ring structure.

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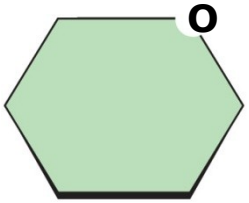

(c) This shape symbolizes the ring structure of a glucose molecule.

Organic Substances
Carbohydrates

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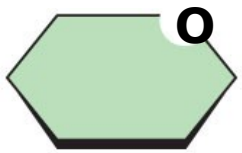

(a) Monosaccharide

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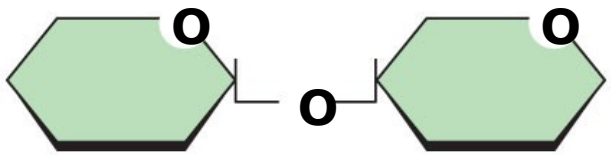

(b) Disaccharide

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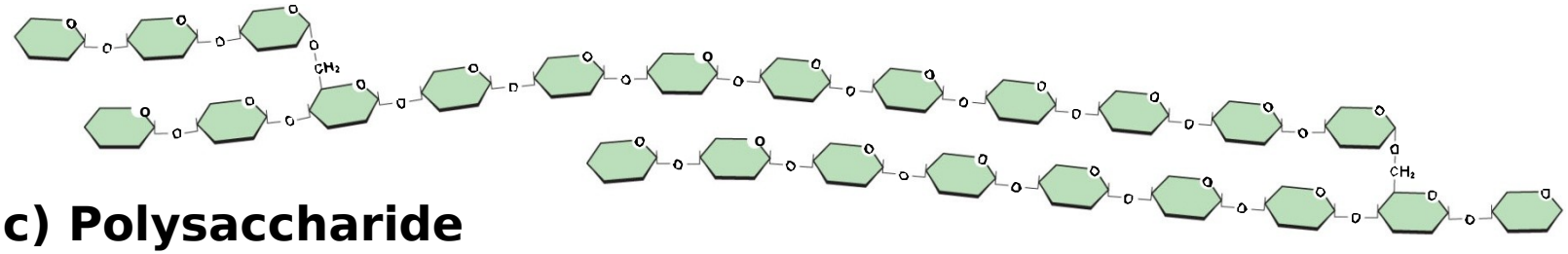

(c) Polysaccharide

Organic Substances Lipids

- Soluble in organic solvents; insoluble in water
- Fats (triglycerides)
  - Used primarily for energy; most common lipid in the body
  - Contain C, H, and O but less O than carbohydrates ($C_{57}H_{110}O_6$)
  - Building blocks are 1 glycerol and 3 fatty acids per molec
  - Satur

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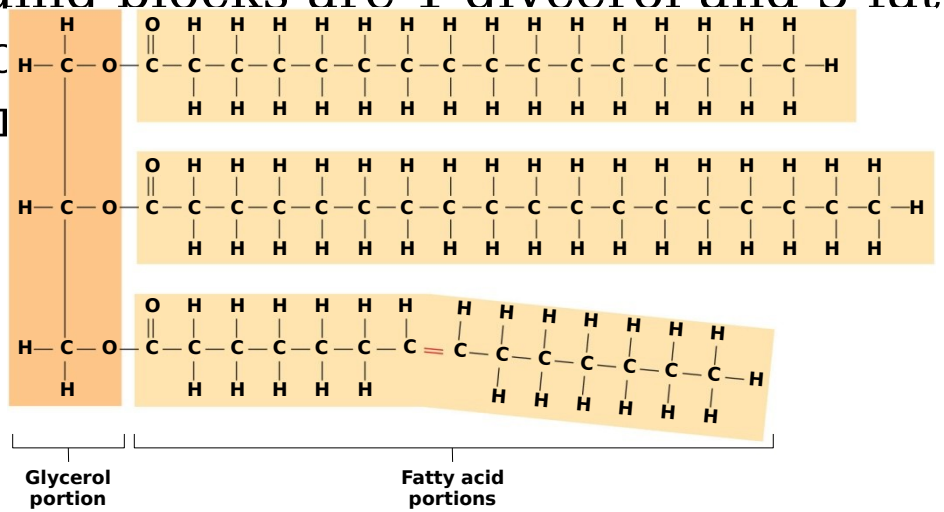

Neutral Fats

- Triglycerides are formed from a fatty acid and glycerol (a sugar).
- They are the most plentiful source of stored energy to our bodies.
  - Two types:
    - Saturated- contain only single bonds
    - Unsaturated- contains one(mono) or more(poly) double bonds
- Short, unsaturated fats are liquids (oils) and come from plants.
- Long, saturated fats are solid (butter and meat fat) and come from animals.

Organic Substances Lipids

- Phospholipids
  - Building blocks are 1 glycerol, 2 fatty acids, and 1 phosphate per molecule
  - Hydrophilic and hydrophobic
  - Major component of cell membranes

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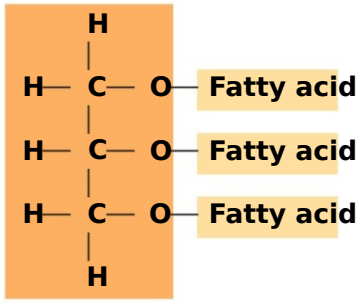

Glycerol portion

(a) A fat molecule

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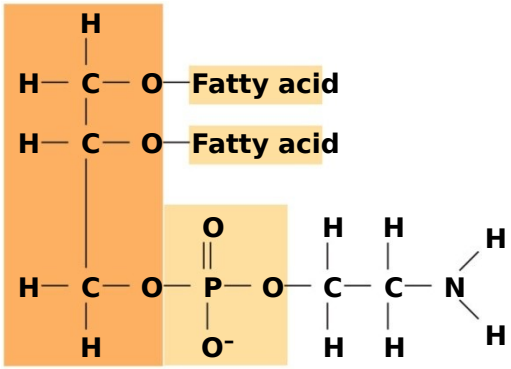

Phosphate portion

(b) A phospholipid molecule
(the unshaded portion may vary)

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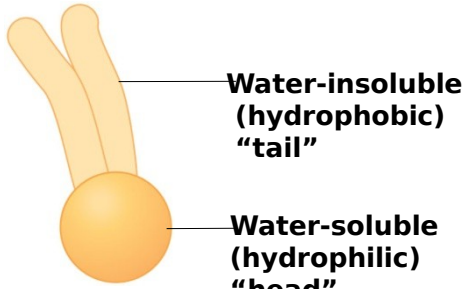

(c) Schematic representation of a phospholipid molecule

Organic Substances Lipids

- Steroids
  - Four connected rings of carbon
  - Widely distributed in the body, various functions
  - Component of cell membrane
  - Used to synthesize hormones
  - Cholesterol

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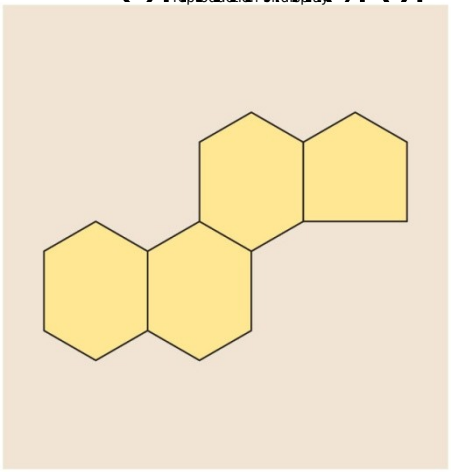

(a) General structure of a steroid

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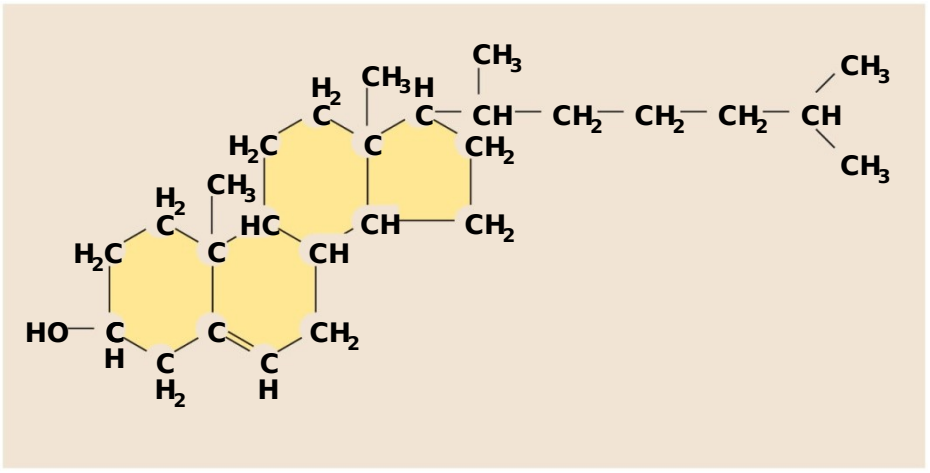
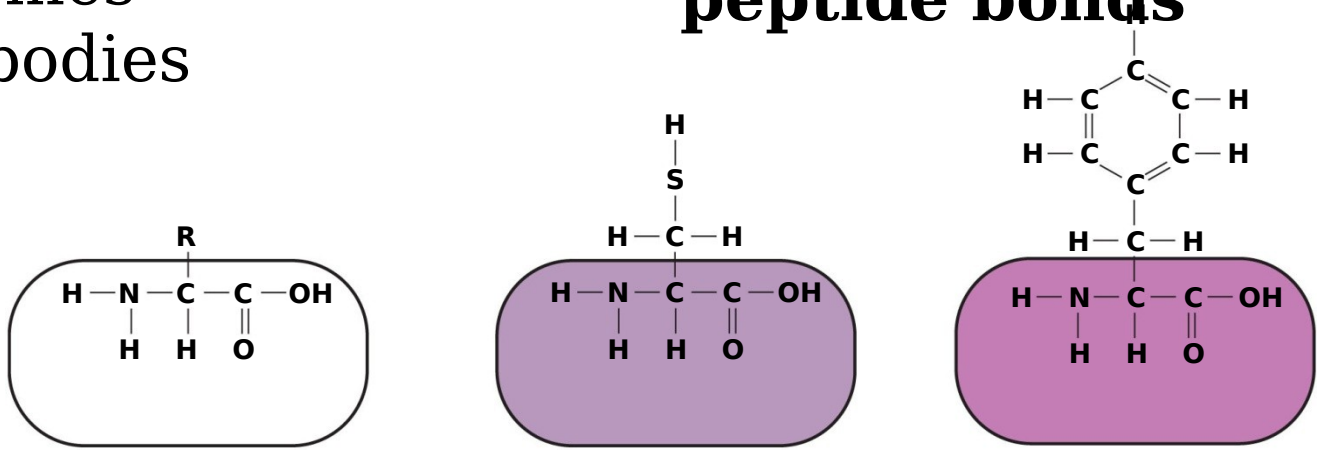


(b) Cholesterol

Organic Substances
Proteins

- Structural material
- Energy source
- Hormones
- Receptors
- Enzymes
- Antibodies

- Protein building blocks are amino acids
- Amino acids held together with **peptide bonds**



Organic Substances
Proteins

Four Levels of Protein Structure

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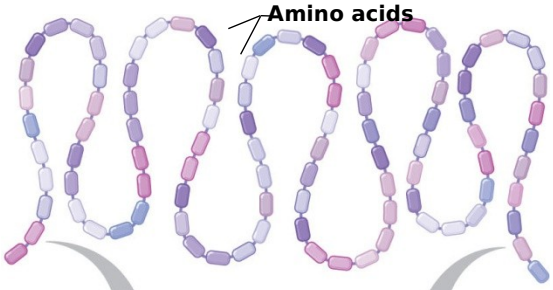
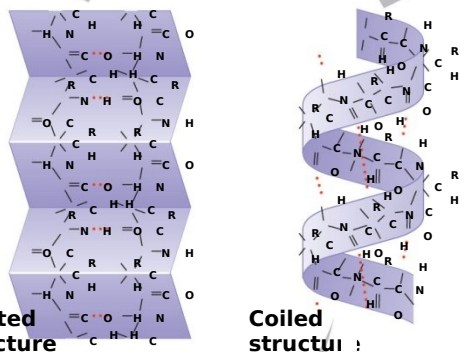
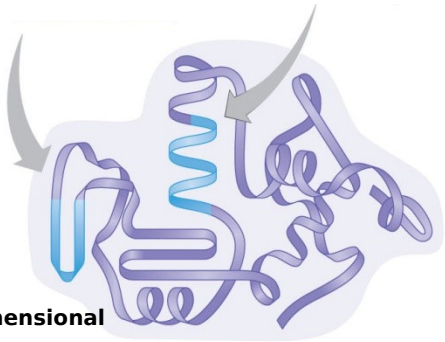
Primary structure



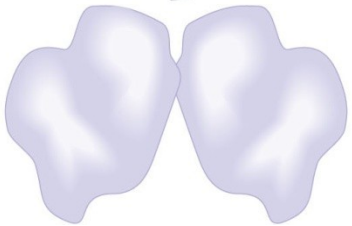
Secondary structure



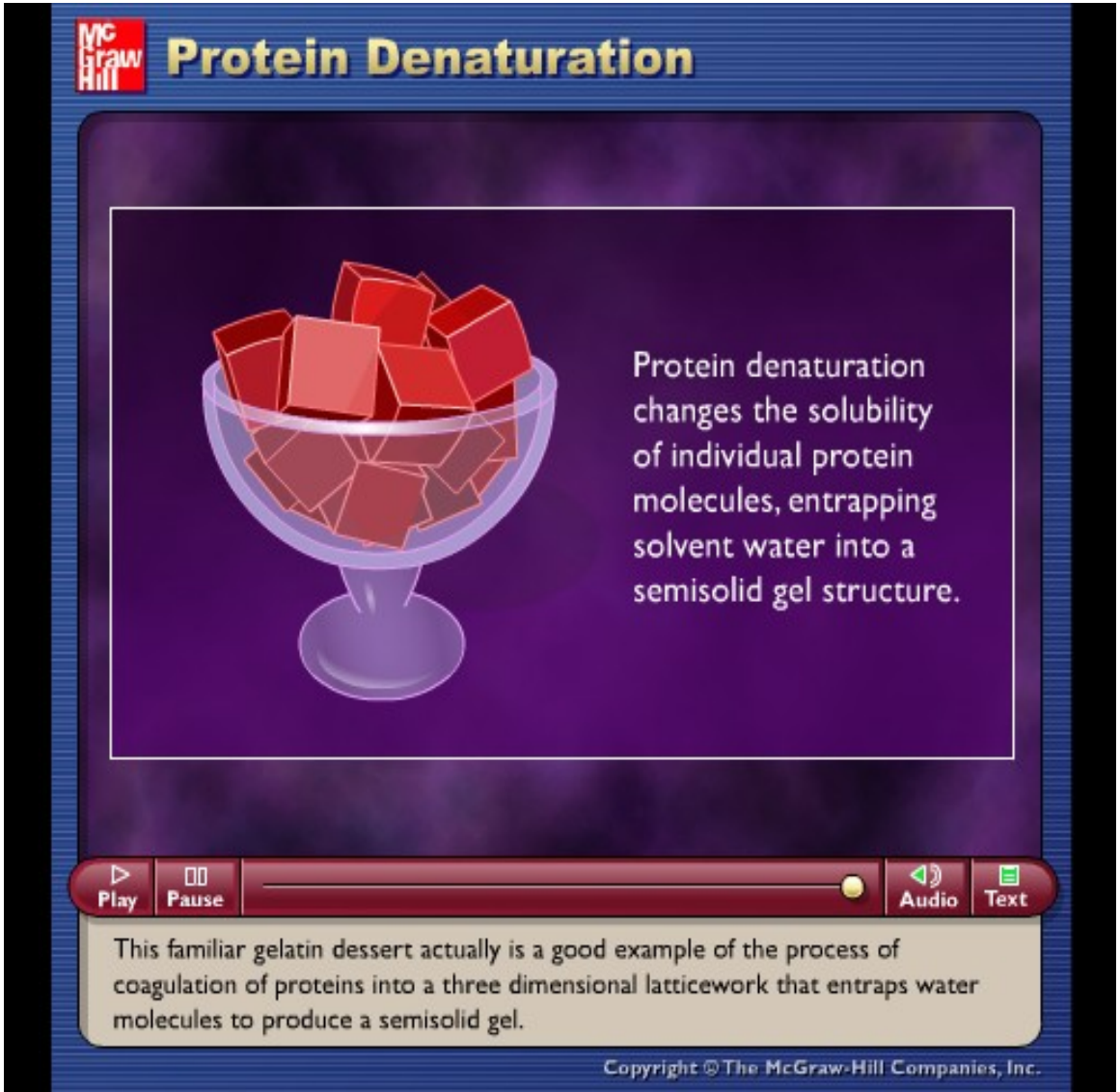
Tertiary structure



Quaternary structure



Animation: Protein Denaturation


Protein Denaturation
Protein denaturation changes the solubility of individual protein molecules, entrapping solvent water into a semisolid gel structure.
Play
Pause
Audio
Text
This familiar gelatin dessert actually is a good example of the process of coagulation of proteins into a three dimensional latticework that entraps water molecules to produce a semisolid gel.
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Organic Substances Nucleic Acids

- Carry genes
- Encode amino acid sequences of proteins
  - Building blocks are nucleotides

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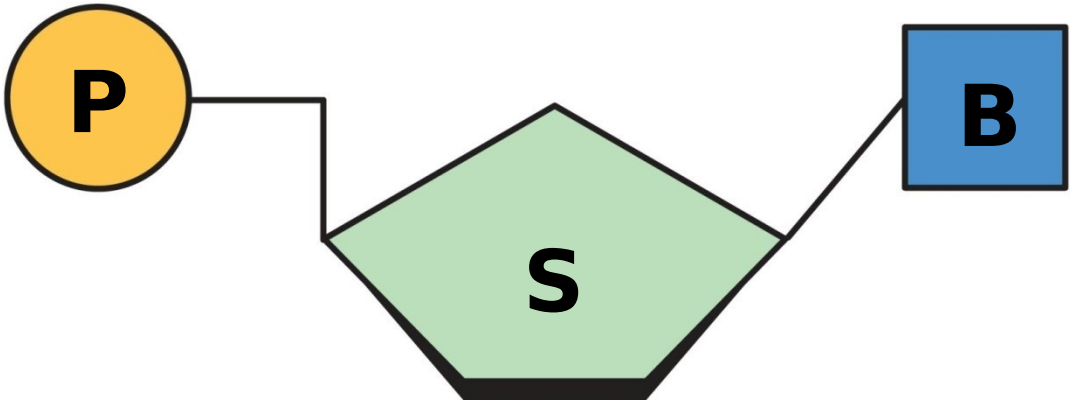

- DNA (deoxyribonucleic acid) – double polynucleotide
- RNA (ribonucleic acid) – single polynucleotide

Organic Substances
Nucleic Acids

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